Eco-Friendly Pest Control for a Sustainable Future

Dr. Fatma Kaplan is a genius in eco-friendly sciences and has the body of research to prove it. She has dedicated her lifelong career to the future of our globe through her entrepreneurial innovations as CEO and co-founder of Pheronym. Pheronym is an agtech startup that produces biopesticides that use pheromones (chemicals capable of acting like hormones to impact the behavior of the receiving individuals) to control a wide range of agricultural pests. We spoke with Dr. Kaplan about how she is using science to create large-scale, positive change.

Your career has built upon your breakthrough research related to nematode pheromone signaling. For those of us who might not know what that means, can you walk us through your discoveries and lightbulb moments?
The lightbulb moment was when I met my prospective postdoc advisor in the line at the Starbucks and he told me about his pending grant proposal to isolate sex pheromones from the microscopic roundworm, or nematode, Caenorhabditis elegans. Having an agriculture background and knowing how effectively sex pheromones were used as an eco-friendly option for insect pest control, I thought this project was worth pursuing and could make a real impact on agriculture.

Of course, this was just talk at that time. My advisor said he would call me when he got funding — and he did two months later. In October of 2005, I started a painstaking two-year journey of natural product chemistry, exploring new scientific territory and ending with a Nature paper in 2008. Identifying C. elegans sex pheromone also concluded decades of debates on whether or not C. elegans actually had sex pheromone. (Since it is hermaphroditic it does not need sex to reproduce.)

From there, the United States Department of Agriculture Agricultural Research Service (USDA ARS) hired me to apply this new finding to agriculturally important nematodes, specifically root-knot nematodes (RKN). Soon I learned that RKN nematode did not need sex to reproduce either. So, I looked for other behaviors that might be controlled by pheromones. I found that dispersal behavior was regulated by the same class of pheromones. Little did I know, the dispersal behavior planted the seed for Pheronym today.

At the USDA ARS, I identified C. elegans dispersal behavior mixture and found that one component of this mixture was a structural analog of beneficial nematodes’ dispersal pheromone. These nematodes are unique and not many people know about them, but they are commercially produced as biocontrol for insects in the soil. The Environmental Protection Agency considers them so safe that they are not regulated. However, they have an efficacy problem in the field. With dispersal pheromone mixture we can make them better and more reliable biocontrol agents.

While at the USDA, I discovered that RKN also recognized C. elegans dispersal pheromone, suggesting that maybe RKN was also using the same class of pheromone for dispersal. We could use pheromone to deter the RKN from plant roots. This became Pheronym’s second product.

How will your innovations make agriculture more sustainable?
Nematode pheromones have a huge potential for sustainable eco-friendly pest control, targeting the pests in the soil, particularly insect and plant parasitic nematodes. They are effective at very low concentration so very little goes into the soil. Since we can dry them and store them as a powder, we can also use them as seed treatment, which is a growing market.

You’ve reached major milestones with Pheronym, including receiving a patent for your technology and recently securing seed funding from angel investors — congratulations! What has been your proudest moment, and what’s your next goal?
I had two major moments when I was over the moon. One when we showed in third party green-house trials that
we can control nematode behavior with pheromones by improving the efficacy of beneficial nematodes against pecan weevil. Proving that the technology worked meant we could move toward manufacturing to bring this technology to the market.

The second was December 5, 2019, when I saw the Dragon capsule on top of a SpaceX Falcon Heavy rocket soaring into the sky carrying my nematode to the International Space Station National Laboratory (ISS NL). I am a big fan of Star Wars and Star Trek, but in my wildest dreams I did not imagine that I could be running an agriculture experiment at the International Space Station!

Yours were the first-ever agriculture biocontrol experiments at the International Space Station. What’s the big idea behind these experiments?
We wanted to know whether beneficial nematode produce the same kind of pheromone in micro-gravity as they do on earth and how we can use these new mixtures. As we were planning the experiment, we realized there were a lot of things we did not know about nematodes in microgravity. Could the nematodes infect insects in microgravity? Could they even move through the soil in microgravity? We planned an experiment to answer those basic questions and published the results in Nature Partner Journals (npj) Microgravity in 2020.

What has it been like to transition from research to founding and running startups — Pheronym and previously Kaplan Schiller Research, LLC?
It was like moving to a new universe (relocating to a new star system) where everything was very different, and the rules of life were changed. I could use my academic skills to raise money by writing grants, which was a temporary fix. Bringing a brand-new technology from bench to market and turning it into a sustainable business, I clearly needed help. So, I sought out mentoring programs, accelerators and incubators. I have learned a lot and I am still learning something new every day.

You’ve described the gender, racial, and ethnic discrimination you’ve faced in your career as “devastating.” How have the challenges been similar or different in academic science versus in entrepreneurship?
I think dealing with discrimination in academic science is a lot more challenging because we are taught that everything is based on merit. If you work hard and follow the rules, you have an equal chance. Since decisions are made based on merit, we are all led to believe that discrimination should not be a problem. On top of that, discrimination is so subtle, it looks like we are exaggerating or oversensitive.
By the time I became aware of discrimination as a problem, it was 2015. I wish I had seen the documentary *Picture a scientist*, or something like it, when I was in graduate school. I must say, I have experienced every single microaggression presented in that documentary at one time or another during my career. Watching that documentary was an eye-opening moment for me.

In business and entrepreneurship, discrimination can be out in the open. If I know there is a possibility of discrimination, I can prepare for it and have a better chance to openly address discrimination whether it is targeted against me or someone else from a marginalized group. If I can identify a problem, I can contribute to solving it. I can also ask my mentors and advisors how to overcome discrimination facing underrepresented founders and the potential pitfalls to avoid during a pitch or a presentation.

The entrepreneurship ecosystem makes an effort to solve the problem. For example, I was recently awarded a prestigious entrepreneurial fellowship from Activate hosted at the Cyclotron Road Division of Lawrence Berkeley National Laboratory. During the application, we were given an application number. We removed all the racial ethnic and gender identifiers from the application. In the one-page CV, we removed all the author names, and only kept publication name, year and journal. Out of 300 applications, my proposal was shortlisted and then I was awarded the fellowship. I believe efforts to reduce bias by removing identifiers can help the advancement of underrepresented scientists, including minorities and women.

Activate recently hosted a workshop for Activate Fellows led by Dr. Kira Banks on diversity, equity and inclusion (DEI). Along with the rest of the entrepreneurial curriculum, we are receiving training on how to incorporate DEI practices into our companies as startup founders. I feel very lucky because even though I have experienced discrimination, it does not necessarily mean that I have all the tools needed to create an environment that promotes equity and inclusion. By fostering dialogue and having access to these important tools, we will be able to create a long-lasting, diverse, equal, and inclusive work environment.

*Editor’s note: In 2019, AWIS partnered with Activate to make its fellowship program for STEM entrepreneurs more inclusive. Read the case study to learn about the key changes Activate made to its fellow recruitment process.*

**Your mentor, Dr. Pam Marrone, is a leader in your industry — and another AWIS member. How did you meet Dr. Pam Marrone? What have you learned about mentorship from that relationship?**

A long time ago when I was looking for a job, I interviewed at Dr. Marrone’s company. After reading about her for my interview, I thought, ‘Oh, she is really amazing! Here’s a strong woman who can lead.’ Being a woman, she became a role model to me. She didn’t know, (laughs) but she

Consumers are increasingly asking about how their food is produced. **Sustainability is top of mind and that means farmers are looking for ways to meet their buyers’ demands.** More attention is being paid to soil health and reduction of farming’s carbon footprint. In addition, synthetic chemicals are being removed or restricted around the globe. As such, biological inputs are the fastest growing crop input category, increasing at an annual CAGR of 15-20% compared to single digits for synthetic chemical pesticides. Dr. Kaplan and Pheronym are right at the forefront of the movement towards more sustainable agriculture, while increasing growers’ ROI. Dr. Kaplan is an extraordinary entrepreneur — she has the verve, intelligence, determination, and work ethic to make it happen.”

— Dr. Pam Marrone, Advisor to Pheronym
did. Her company Marrone Bio Innovations was a natural products company providing eco-friendly pest control, which is what Pheronym is about, and I got a lot of ideas by looking at her website.

In 2017, I was in San Francisco for the Indie Bio Accelerator Program, and coincidentally near UC Davis, where Dr. Marrone works. I emailed her and she very promptly responded. That was the first time we met in person. After this, Dr. Marrone became a mentor in a California Life Sciences Institute Fellows of All Star Team business advisory program. We had meetings every other week from September-December. After that, I didn’t let her go…I would always ask her questions because she is such an experienced person and a leader in biopesticides. Afterwards, we asked her to be our official advisor and she said yes.

She has been very supportive of women entrepreneurs. I feel very lucky to call her my friend and mentor. She encouraged me to become an AWIS member. I like her style. She is very respectful, generous, supportive and positive. Most importantly, she believes in women entrepreneurs; that we can make great leaders and positive changes in agriculture. That is the kind of advisor we all need.

What does collaboration in science mean to you? Do you have any dream collaborators?
I build collaborations to get projects done. Every stage of Pheronym’s development has brought new needs, and I’ve had to collaborate with new people to meet those needs. Right now, I am putting together a collaboration with the Advanced Biofuels and Bioproducts Process Development Unit, the Joint BioEnergy Institute at the Lawrence Berkeley National Laboratory (LBNL) to scale up Pheronym’s pheromone production using bioreactors.

I can mention the dream collaborators we had so far. The International Space Station! (Laughs) In collaboration with ISS NL, we conducted the first agriculture biocontrol experiment in micro-gravity using beneficial nematodes for insect control. With USDA ARS, I was able to do laboratory and greenhouse trials to show that technology works. Currently, we are conducting field trials at the USDA orchards in Byron, GA. With LBNL, we are going to scale up our manufacturing.

I think 5 years from now, I will add many more dream collaborators to this list.

How did COVID affect Pheronym? What are your future hopes & goals for Pheronym?
COVID disrupted us fairly seriously. We did the best we could. Technically, we should have submitted our Phase II Small Business Innovation Research (SBIR) by now, however we temporarily suspended our lab work at the UC Davis HM Clause Innovation Center because of the government shutdown in March 2020. So we decided to focus on market research. Several months later we returned to the lab, but because of social distancing, we were not in the lab full time. A field trial that we had planned for last Spring was delayed because the research facility was shut down due to COVID. Fortunately, we are able to do that this year. Though COVID caused a big disruption in our work, we are managing the best we can.

Currently there is no commercial manufacturing for the nematode pheromones. My goal is to create a manufacturing system. Luckily, we recently got funding from angel investors to do just that. Businesswise, I want to get into the market within 2-3 years so we can see how farmers experience the product.

What is your favorite part about being an AWIS member? What advice would you give someone looking to use her science to solve challenges in the world?
If you think your science can make a difference, you should pursue it. Then figure out your strengths and weaknesses so you can focus on your strengths, which will make you succeed. Don’t ask for permission. Don’t wait for the perfect time, which never shows up. You have to start somewhere. The place where you are right now is the best time and place to start. Surround yourself with positive and supportive people who believe in you.

For women, support is very important. A woman may not be encouraged to go into science, but I think we have a lot of talent, because there are a lot of women PhD’s out there who have the power to think analytically. I think women have a lot of strength. We can make a big and positive difference.

Many women have very similar experiences in science, regardless of our background. I feel I have something in common with all of them. I feel a bond with all the AWIS members because of our common interest in science. It’s helpful to have someone that understands what you’re going through.